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USSR Report

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

No. 70

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USSR-HUNGARIAN COOPERATION

Moscow SOVIET EXPORT in English No 1, Jan-Feb 83 pp 34-36

[For article entitled "Potential For, Obstacles To, Wider Computer Use Explored" from EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA No 10, October 1982 see JPRS 82943, 24 February 1983]

[Text] Trade relations between the USSR and Hungary are developing actively. In 1971-1975 the scope of mutual deliveries amounted to 11.2 thousand million roubles, in 1976-1980 it was twice as much. The share of machines and equipment in the Soviet export to Hungary amounts to about 20 per cent; in Hungary's export to the USSR it equals 50 to 52 per cent. About half the products, computers among them, are delivered under specialization agreements. Under the intergovernmental agreement, the Soviet Union sells Hungary large- and medium-scale Unified System computers, as well as minicomputers of the SM series and Elektronika series microcomputers. Hungary, for its part, exports to the USSR small-scale ES-1012 and ES-1015 computers, various peripherals.

Our special correspondent V. Ye. Demidov examines Soviet-Hungarian co-operation in the field of electronic computer technology. Here is the story.

--We import computers,--says Aladar KOVACS, General Director of the Metrimpex foreign trade enterprise,--and I can state with satisfaction that Soviet computers are in great demand here. ELGORG ranks fourth on the Metrimpex list of Soviet suppliers, 20 in all. We, for our part, are delivering to the Soviet Union a computerized railway ticket booking system, jointly designed by Soviet and Hungarian specialists.

--I would like to show you one of the "oldest" computers delivered to Hungary,--said Geza NYIRY, director of NOTO OSZV, the Hungarian national organisation for computer equipment maintenance and servicing.--This is a Minsk-32 computer. It was put into operation in 1970 and since has been continuously operating at the Etves Institute of Geophysics. Of course, during the past years we have made several improvements in the computer: with the help of Soviet and Hungarian specialists, for example, we added a number of peripherals, such as plotters or a new high-capacity storage unit. The computer has proved to be highly adaptable to new technology and as far as I know, the Institute has no intention of parting with this machine, although it has bought ES-1035 computer. Incidentally, this new machine is also Soviet made...

--Without the vast Soviet market Hungarian industry would not have been able to develop co-operation and specialisation in the manufacture of computers and peripherals on such a grand scale,--said Ilona VARGA, chief of the market research department in Videoton, the largest Hungarian exporter of computer facilities.

Soviet-Hungarian trade and technical relations in the field of computer technology are highly diversified. The development of these relations was particularly promoted by the multilateral intergovernmental agreement of 1969 on the co-operation of socialist countries in developing and manufacturing Unified System computers.

About 120 Soviet computers of different types are currently in operation in Hungary. They are used at all levels of economic management, from the Central Bureau of Statistics down to individual enterprises.

--We have a governmental programme for developing computer technology,--said Deputy Chairman of the National Council for Technological Development Janos SEBESTYEN. It was adopted in the late 1960's and embodies the ideas of multilateral co-operation of socialist countries in this field. We finance the setting-up of so-called pilot computation centres for testing computer configuration and software. Depending on the scope and complexity of the tasks, we are going to use Soviet or Hungarian computers. However, the predominant portion of computers will be imported from the USSR. Soviet computers have amply proved their high reliability and excellent performance characteristics.

Indeed, you will not find a single large city in this country which does not have Soviet computers--Gyor, Szombathely, Pecs, Szeged, Debrecen, Miskolc and others, to say nothing of Budapest.

The computation centres of Hungary's Central Bureau of Statistics are equipped with ES-1035 type computers. These machines perform 180,000 operations a second, have a main memory of 1 Mbyte capacity and a virtual memory, and can operate in the block-multiplex mode. They are used for collecting and processing statistical data pertaining to manpower, materials and equipment, transportation, etc. In the spring of 1981 the last of the regional centres of the Central Bureau of Statistics received an ES-1035 computer, which has completed the programme of replacing computers in these centres with new machines, of the Unified System.

It we turn to industry, Soviet computers work at such well-known plants as the Ikarus bus plant, the Csepel iron-and-steel works, the Aluminum complex and many others. The ES-1020 and ES-1022 computers have already been in operation there for several years.

At present a still larger number of users buy Soviet-made SM-4 type minicomputers and Elektronika-60 and Elektronika-120 microcomputers. They are used either independently, or as "intelligent terminals".

--We are actively co-operating with the ELORG Technical Centre in the purchase, installation, servicing, and procurement of spare parts for Soviet computers,--stated G. Nyiry, director of NOTO OSZV.--The assistance of Soviet specialists is particularly valuable when we start installing new types of computers that are little known to Hungarian engineers and technicians. NOTO OSZV is staffed with about 500 Hungarian specialists many of whom have been trained in the Soviet Union, while others acquired experience through close cooperation with Soviet colleagues in Hungary on short-term business visits or permanently employed at the Technical Centre.

We all have specific areas of responsibility. The personnel of the Technical Centre represent the seller, workers of NOTO OSZV represent the buyer. Now our specialists help the users to choose the configuration of the computer, give their expert advice, while Soviet experts evaluate the practicality of specific requirements.

NOTO OSZV undertakes restructuring of premises for computation centres, and the workers of the ELORG Technical Centre give all necessary consultations on the location of a concrete computer to suit the recommendations of the manufacturer.

--We attach particular importance to the provision of spare parts and to servicing in general,--Denis SALTYKOV, General Director of the Technical Centre, for his part emphasized.--We have two storehouses with spares, so that supplies can be arranged at short notice. For Hungary, where transportation distances are quite short, this means that if we receive a telex requesting service, spare parts are on the sport within hours.

The Technical Centre is being furnished with new equipment. In 1982 we shall put into operation the SM-4 and Elektronika-60 computers which are going to be reference machines for checking repaired standard interchange elements brought here from operation sites, if the case is particularly complex. Besides, these computers will be used for training Hungarian specialists and providing know-how to the users.

I got an invitation from Hungarian specialists to visit the Hungarian Optics Plant, founded more than a century ago. Almost 30 per cent of its output goes to the USSR; is export list also includes fixed-head disk stores.

--At the beginning of the 1960's,--said Gyula POSCH, General Director of the plant, we started implementing a programme for producing electronically-controlled laboratory instruments. We have established friendly relations with Soviet research institutes working in the same field. Today, our export to the USSR is 26 million roubles; during the past decade it has grown four-fold.

The general director told me that Soviet consultants were instrumental in selecting computer system equipment to be produced by the factory.

--We have started production of fixed-head disk storage units. These units are in great demand in all socialist countries, particularly in the USSR; we are also delivering them to France.

Deliveries to the USSR are of particular significance for the factory, since the Soviet Union offers us a vast, steady and continuously growing market, Moscow and Leningrad research institute have helped us a lot in mastering the new products.

--It is now five years,--concluded G. Posch,--since a Soviet ES-1022 type computer has been working at the factory. We are employing it for all kinds of management applications, ranging from accounting and pay roll computation to the problems of supply and preparations of contracts with foreign buyers and suppliers.

However, our activities are growing, and the speed of the computer cannot keep pace with the progress. We are now planning to buy an ES-1035 computer; I believe that the capabilities of this machine will meet all our requirements for the nearest 10-year period.

In 1981 ELORG organized an exhibition of electronic components in Budapest and it displayed a very wide variety of components, from resistors to large integrated circuits. The exhibition was extremely successful. It was visited by about 25,000 people, at least 3,000 of them specialists of electronic, radio engineering and computer enterprises. Soviet specialists delivered several lectures on the prospects of using components, especially integrated circuits. Great interest was shown in microprocessors which can be programmed to control any domestic appliance, from telephones to washing machines and electric ranges, and are also suitable for much more sophisticated computer applications.

--I think that organisation of such a representative exhibition was extremely well-timed,--said Gabor IKLODY, General Director of the Elektromodul foreign trade enterprise.--In any electronic product components account for up to 70 per cent of the product's cost price. Since a huge part of the Hungarian electronics export is for marketing in socialist countries, we are trying to use, as much as possible, standardized components in these products. Among socialist countries, the largest manufacturer of these components is the Soviet Union and therefore our association attaches great importance to the import, of Soviet electronic components, in particular, microcircuits and microprocessors.

The conversation was continued in Videoton, a foreign trade organisation, which has already exported to the USSR some 400 ES-1010 and ES-1012 computers as well as the first ES-1015 machines. The latter are new items on the Hungarian export list which have recently passed international tests under the programme of the Intergovernmental Commission for co-operation between socialist countries in the field of computer technology. Small-scale computers with a relatively low speed, they are extremely convenient for dealing with various applications in factory management. In the USSR these computers are employed for railway transport management, in power engineering, oil production and in other industries.

--ELORG is Videoton's largest customer,--said I. VARGA,--and we always take into consideration all the remarks made by Soviet users. They have an extremely rich experience of work with our computers, and at each conference--which we convene regularly--Videoton designers get a lot of important imformation. This helps us improve computer designs continually so that they could meet the market's requirements to the maximum.

Mutual ties between the USSR and Hungary in the field of computer technology are becoming more close and extensive. The Hungarian side shows interest in Soviet-made high-power computers. Negotiations are going on about deliveries to Hungary of such high-performance computer systems as the ES-1060 with a speed of more than 1 million operations a second.

CSO: 1863/98-E

HARDWARE FOR DATA TELEPROCESSING: AP-4

Moscow VESTNIK STATISTIKI in Russian No 2, Feb 83 pp 37-42

[Excerpts from article by Candidate of Technical Sciences A. Kryukov, Candidate of Technical Sciences V. Monakhov, and V. Vasil'chenko (Collective-Use Computer Center of the Estonian SSR Central Statistical Administration): "Data Teleprocessing by Collective-Use Computer Centers"]

[Excerpts] The current stage in the development of data teleprocessing is characterized by an increase in both the number of collective-user networks and the number of users in each network. This has created some difficulties, primarily associated with the absence of the needed number of assigned telephone channels and data transmission multiplexers. Also of considerable difficulty is the development of the software for organizing exchanges between computers and user terminals. One efficient way of overcoming these obstacles in setting up data teleprocessing networks is the use of the AP-4 (YeS-8504) user terminal as a data concentrator, i.e., as a unit for independently exchanging data with other user terminals and computers.

The AP-4 is a widely used, serially produced user terminal including a processor and various data input-output units, including magnetic tape storages. The general AP-4 software is embodied in an operational system incorporating the means for:

organizing simultaneous and independent operation of the user terminal's input-output units;

exchanging data between the user terminal's input-output units and the central computer;

merging data input-output operations and exchange;

organizing the operation of processing programs.

The signal convertor is a 2400 modem (YeS-8010) included in the AP-4 pack; it transmits data along an assigned four-wire telephone channel at rates of 600, 1,200, and 2,400 bits per second.

Data exchange between the AP-4 and the computer is effected according to a subordinate mode binary synchronized control procedure. This means that the computer initiates and organizes the operation of the user terminals. The

proposal to use the AP-4 for controling data exchange with other user terminals (instead of the computer) is based on the following considerations.

1. The AP-4 has a built-in control mode which enables the user terminal to initiate the phase procedure in the data transmission element by sending a SIN [expansion unknown] sequence to another user terminal. (The mode is activated by briefly throw the RSh switch on the AP-2100 processor panel.)

2. The series of commands for linking up the unit with the AP-2100 line makes it possible to program control procedures in the data element, taking into account specific features of different user terminals.

Thus, AP-4 hardware and software make it is possible to exchange data within a user network in different modes AP-4--AP-4; AP-4--AP-63 (AP-61); AP-4--YeS-7920. To organize exchange in the AP-4--AP-2 mode it is necessary, in addition to developing the relevant AP-4 software packages, to replace the 2400 modem by the 200 modem (YeS-8001), which provides operation along both the assigned four-wire and switched two-wire telephone channels at a rate of 200 bits per second.

The use of the AP-4 as a data concentrator makes it possible to construct bilevel user networks of data teleprocessing, variants of which are presented in the figure. Network (a) collects data (in sessions) from distant sources along switched communication channels and then transmits them on to the computer. It should be noted that in replacing 2400 modems with 200 modems and appropriate AP-4 software, communication is possible in the AP-4--AP-4 and AP-4--computer modes along switched two-wire communication channels. Network (b) is intended for servicing multi-panel complexes along assigned communication channels. In such a network it is possible to prepare large data arrays and transmit them along a communication channel to the computer, as well as to display data stored in the AP-4 (including data received from the computer) on CRT's. Besides interaction of the AP-4 as a concentrator with the computer along communication channels, there is also the possibility of delivering magnetic tapes from the AP-4 to the computer and back (when they are located fairly close). The design of the magnetic tape storages and the YeS computer operational systems provides for magnetic tape readout and storage units using tape with 8 pulses per millimeter density of the type which is used with the AP-4. Exchanging magnetic tapes between the AP-4 and the computer makes it possible to substantially reduce data transmission time, as well as to acquire data from remote subscribers in the absence of teleprocessing hardware and software at the computer center. A specific feature of network (c) in the Figure is the use of an AP-4 as a concentrator directly hooked up with the computer through an AP-4060 adapter[1]. Unlike the other circuits, here the interaction of the AP-4 with the computer and a remote user terminal can take place simultaneously, not in sessions. The computer operates with the AP-4 as with an external unit, which considerably simplifies the hooking up of the data teleprocessing with previously set up automatic control systems.

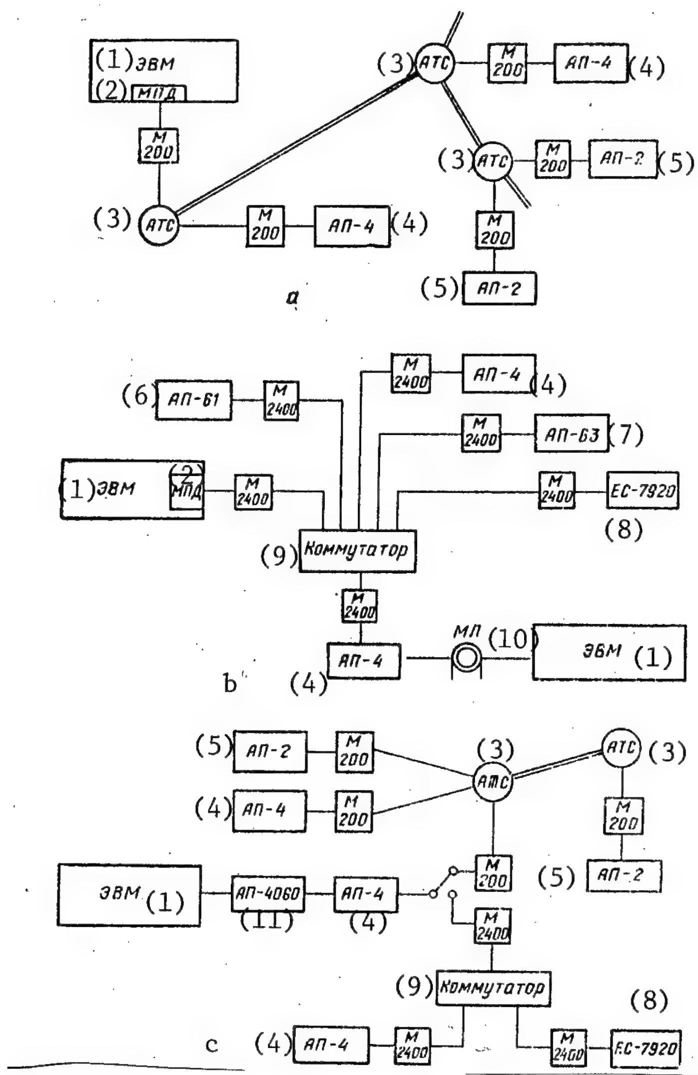

Fig. Variants of user networks with the AP-4 as a concentrator: a - along switched two-wire communication channels; b - along assigned communication channels; c - along mixed communication channels with an AP-4060 adapter.

Key:

1. Computer
2. Data transmission multiplexer
3. Automatic telephone exchange
4. AP-4
5. AP-5
6. AP-61
7. AP-63
8. YeS-7920
9. Switch
10. Magnetic tape
11. AP-4060

Below are considered the specific features of the software for the AP-4 as a concentrator. The basis of the software is the AP-4 data control system[2], which is designed for preparing, inputing, accumulating, storing, retrieving, editing, outputing (documenting) and real-time displaying of data, as well as exchanging data with the computer along a communication channel.

A data teleprocessing network based on interaction of an AP-4 with other user terminals has been set up at the Collective-Use Computer Center of the Estonian SSR Central Statistical Administration. Studies going on there on the possibility of transmitting data along two-wire switched telephone channels at a rate of 600 bits per second are, in our view, of interest. This would make it possible to improve the efficiency of equipment. Another aspect of the use of the AP-4 is the output of color data on the basis of two synchronized AP-7060 CRT's and a standard color TV. Thanks to color reproduction the setup improves the quality of output arrays of letter-digital information in the automatic control system. Speaking of the development of the AP-4 as a concentrator, we should like to note the following desirable fields of improvement: development of a self-contained line hookup unit connected with the processor along the "T" interface; increasing the number of input-output units hooked up with the processorto 16 to 32; hooking up a magnetic disk storage to the processor; industrial manufacture of the AP-4060 adapter and incorporating the AP-4 in it; development of a special AP-4 operational system; incorporation in the AP-4 of a modem and a calling unit for operating along switched two-wire communications channels.

FOOTNOTES

1. See Ye.P. Basov, "Kompleks ustroystv vvoda-vyvoda i obrabotki graficheskoy informatsii YeS-7908 dlya YeS EVM" [The YeS-7908 Complex of Input-Output and Graphic Data-Processing Units for the Unified System of Electronic Computers], VOPROSY RADIOELEKTRONIKI, SERIYA EVT, vyp. 4, 1978 pp 14-20.

2. See E.N. Belov and V.Ye. Monakhov, "Programmiruyemyye abonentskiye punkty dlya ASU" [Programmable User Terminals for Automatic Control Systems], INF. BYULLETEN', GOSINTI, 1978, No 7.

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ROLE OF AUTOMATED CONTROL SYSTEMS IN TRADE MANAGEMENT

Moscow SOVETSKAYA TORGOVLYA in Russian No 12, Dec 82 pp 22-25

[Article by A. Shpagin, General Director of the All-Union "Soyuztorgsistema" Association, USSR Minister of Trade and Candidate of Technical Sciences: "ASU's in Service"]

[Text] With the constant increase in commodity turnover, the expanding assortment of commodities and the necessity of maximum utilization of existing resources, the operational efficiency of trading enterprises and organizations is depending to an ever greater extent on management quality. At the same time, with the increasing number of economic links between trading organizations and enterprises, the growth in the complexity and the dynamic nature of economic management processes, it is becoming difficult to find and apply the optimum management decisions, while intuition increasingly is letting managers down. Every year, the demand for a scientific substantiation of the management decisions being made increases, as does the need for the transition of management to a qualitatively new level based on the utilization of the latest management methods and technology, as well as the increasingly widespread application of automated control systems (ASU's), mathematical economics techniques and modern communications and computer facilities.

Work on the use of computers in trade management started in 1967, when computer centers were created in the Leningrad "Gostinyy Dvor" department store and the Moscow GUM [state department store]. During this time, the computer center at Gostinyy Dvor became an important link in the management system for not just the department store, but for all Leningrad trading. It rendered no small amount of assistance to the staff and the creation of other computer centers in the sector. At the end of the 1960's and the beginning of the 1970's, computer centers were set up in the trade management administrations of the Kiev city soviet executive committee, the Khar'kov oblast soviet executive committee, the Lithuanian SSR Ministry of Trade and the Moscow municipal office of "Rosmyasomoltorg" [RSFSR Republic Meat and Dairy Products Trade Administration]; the "Rostorgmashuchet" enterprise was created in the RSFSR Ministry of Trade, where this enterprise was later converted to the republic level association, "RosASUTproyekt". Work on the introduction of computers has been stepped up significantly in many union republics in 1972, when the All-Union Association "Soyuztorgsistema" was created as part of the USSR Ministry of Trade.

Much has been done over the past years to improve trade management based on the introduction of computer equipment and the creation of ASU's. As of January 1st, 1982, 110 automated control systems based on 65 computer centers were in service in the USSR Ministry of Trade System. Work on the introduction of ASU's is now being expanded in all union republics. The work is underway on a wide scale and most actively within the ministries of trade of the Ukraine, Belorussia, Russia, Kazakhstan, Moldavia, Lithuania and Latvia. Automated control systems are in sercive within the organizations of 12 union republic ministries of trade, in 23 main and oblast level trade administrations, ministries of trades of autonomous republics as well as 38 wholesale and 23 retail trade organizations and enterprises.

The experience of republic level ministries of trade and tradining organizations and enterprises with the creation of ASU's, the introduction of computer hardware and the regular investigation of automation facilities being carried out by the All-Union "Soyuztorgsistma" association, the "RosASUTproyekt" and "Ukrtorgsistemtekhnika" republic level associations, as well as by the "Beltorgsistema" planning and technological institute attest to the improvement in the technical and economic indicators of trading organizations and enterprises where ASU's are employed, as well as their substantial economic and social impact. Thus, the retail trade turnover of trading organizations in Gor'kovskaya oblast which enjoyed the services of computer centers increased by 26.4%, while that of local trading as a whole increased by 21.8% and their income rose by 32% and 28% respectively. After five years of operation with an ASU in Gor'kov TsUM [central department store], goods turnover rose by 37%, income by 40% and the productivity of administrative labor grew by 44.5%; the overdue debt for goods sold on credit was reduced by a factor of eight times. The level of turnover costs in practically all automated facilities is below the average republic level. For example, for the trade administration of the Gor'kovskaya oblast soviet executive committee, it is on the whole 40.1% below the average for the RSFSR Ministry of Trade; in the Moscow GUM, it is 24.4% lower and in the Vilnius "Detskiy Mir" department store it is 13.4% below the average for the Lithuanian SSR Ministry of Trade.

The introduction of the ASU for the trade administration of the Karagandinskaya oblast soviet executive committee made it possible to obtain an additional increase of 92,000 rubles in goods turnover and reduced expenses by 103,000 rubles, including credit percentage outlays of 90,000 rubles.

Calculations performed within the framework of the USSR Ministry of Trades OASU [automated control system for the sector] for certain groups of goods showed an approximate reduction of 500,000 rubles in the transportation costs for the shipment of consumer goods as well as the freeing of a considerable number of freight cars. The introduction of mathematical economics methods in the ASU of the Kazakh SSR Ministry of Trade has substantially boosted the quality of the planning of commodity turnover and commodity resources in the oblasts, which promoted an increase in commodity turnover and an improvement in the utilization of the commodity resources.

The ASU at the Ukrainian republic wholesale fair for footwear freed 90 persons and curtailed the duration of the fair through the automation of labor intensive manual operations. The processing of the results of the fair took 10 days in all instead of the usual one-and-a-half to two months. Prior to the introduction of the ASU, the draft of the production plant showed a shortfall, as a rule, of 60 to 70 million rubles, but in 1979 when the system was used, it was fully funded.

Automating the calculations for goods sold on credit has a significant economic and social impact. Such a set of tasks has been introduced in the trading enterprises of numerous republics. In the Main Trade Administration of the Moscow city soviet executive committee, more than 2,000 accounting workers were required to handle the personal accounts of 800,000 purchasers according to the set standards, and there were 197 workers in all. The automation of these calculations made it possible to reduce the overdue credit debt by one million rubles, eliminate 57 bookkeepers and yielded a direct economic savings amounting to 200,000 rubles.

The impact of ASU's and computers on the overall growth in the labor productivity of trade workers is clearly illustrated by the data for the Main Trade Administration of the Leningrad city soviet executive committee, where an especially great amount of attention is devoted to the introduction of ASU's. Thus, while the number of workers in the USSR Ministry of Trade System needed to realize one million rubles of commodity turnover fell by 16% during 10th Five-Year Plan and amounted to about 19 persons, these indicators were about 40% and 13 persons respectively in Leningrad retail trade. In the Main Trade Administration of the Leningrad city soviet executive committee, the number of enterprises not fulfilling the plans has been reduced by a factor of more than 10 times. In the opinion of the management of the main administration, the ASU and computers rendered no small service in this regard, where these promoted a substantial improvement in the quality of commodity turnover planning, improving the operational timeliness of monitoring the fulfillment of the commodity turnover plan as well as monitoring the allocation of commodity resources.

Computers yield a perceptible economic and social impact by increasing the quality of accounting and improving the preservation of material valuables. While the amount of shortages, waste and misappropriations in the USSR Ministry of Trade system during the 10th Five-Year Plan was reduced by 45%, it was reduced by 270% in Leningrad trade.

In the USSR Ministry of Trade system, the overall savings from the introduction of ASU's in the past five-year plan amounted to 25 million rubles.

The All-Union "Soyuztorgsistma" Association, the "RosASUTproyekt" and the "Ukrtorgsistemotekhnika" republic level associations as well as the " "Beltorgsistema" PTI [planning and technological institute] and computer centers have done considerable work in recent years to boost the scientific and engineering level of the ASU's being introduced and to curtail the timeframes and cost of their construction. This is related first of all to an increase in the skill level of the designers, who now have better knowledge of trade economics and organization. The set of tasks for ASU's and the techniques for accomplishing them have become more substantiated and closer to the practical needs of the trading system.

The party line on the stepped up role of trading in mutual relationships with industry is reflected in the creation of comprehensive intersectoral management systems, the solution of problems involving the study and prediction of demand, as well as more detailed accounting for the implementation of delivery agreements as regards time and assortment. Examples of such systems are the intersectoral automated control system for marketing and deliveries of commodities in light industry and trade of the Belorussian SSR, as well as the comprehensive intersectoral automated system for managing the supply of commodities in the light industry products list, developed by the Ukrainian SSR Ministry of Trade in conjunction with the republic's Ministry of Light Industry. The "Beltorgsistma" PTI is doing interesting work on the creation of an integrated and automated organizational and production process control system for managing the oblast wholesale base, which provides for the automation of the technological processes of storage and selection of nonfood commodities and the automated processing of trading and economic data at the "Kul'ttorg" Minsk wholesale base. The experience of the central planning and technological institute of the "Soyuztorgsistma" All-Union Association in the development of the working engineering plan for the ASU wholesale base at Bryansk is being utilized in this work.

The share of accounting tasks in the overall volume of ASU tasking has been reduced to approximately 50%, while in management systems at the sectoral, intersectoral and regional management levels, it amounts to 41.3%.

A shift has been noted, although as yet in adequate, towards the expanded use of mathematical economics techniques in the solution of ASU problems. Thus, about 60% of the ASU's being designed now provide for the application of these methods to the solution of no less than 5% of the problems, while in a number of systems, the number of problems being solved through the use of mathematical economic techniques is approaching 50%. Forecasting and optimization tasks are becoming increasingly widespread.

The trend towards an increased percentage of operations tasks is developing on a wide scale. Control systems for managing retail and wholesale trade enterprises are now frequently automated, in which many problems are solved on a daily basis. The number of information and referral systems has increased, where these make it possible for trade workers to interact directly with the computer in the solution of the problems which arise. A dialog made is employed in approximately 45% of the ASU's being designed. In step with the increased delivery of displays to the trading system and the improved utilization of communications channels, the role, significance and efficiency of information and referral systems will steadily increase.

The increased attention devoted to ASU design by trade organization and enterprise workers, especially the primary managers, has played a significant part in boosting the efficiency and quality of ASU's. The introduction of ASU's requires a high level of organization in the work of a trade enterprise, good knowledge on the part of workers in the facility where the planning decesions are automated as well as an understanding of their role in the automated management process. It goes without saying that the introduction of an automated control system is a complex process, which initially is frequently painful and labor intensive, requiring considerable additional work. Nonetheless,

practice shows that where the necessity of improving management, applying computers and mathematical economics techniques are understood and where managers of trade organizations devote the requisite attention to these questions, the costs and timeframes for ASU introduction are less while the impact of the ASU greater.

It is impossible to shorten the timeframes and reduce the cost of creating ASU's for trade systems, or to improve their scientific and technical level and efficiency without widescale standardization and duplication of the design solutions as well as the requisite scientific and procedural support. According to the data of an analysis performed by the "Soyuztorgistma" All-Union Association in conjunction with the planning and technological organizations of the sector, standard designs were utilized in 46.7% of the ASU's introduced or under development in 1981, while standard project plans were employed in 17.7% of the ASU's. In 1982, specialists of the "Soyuztorgistma" All-Union Association in conjunction with designers in other organizations carried out a thoroughgoing analysis of the project plans for ASU's presently in service in wholesale organizations and enterprises. The analysis made it possible to single out the better systems and recommend for use in the creation of ASU's at other wholesale trade facilities. These are the project plans for the "Torgodezhda" ASU (Vitebsk), the "Rostekstil'torg" ASU, "Estobuv'torg" and "Moldbakaleya" ASU. The bookkeeping, accounting and financial management subsystem are being widely duplicated on a regional level, as well as the complex of tasks for automation of the calculations of commodities sold on credit in the retail trade organizations.

Considerable work has been done on the standardization of information support and software. Some 17 All-Union and 5 sector level classifiers of technical and economic information with an overall volume of one million positions have been developed, approved and are in use in the sector. The approval of a standard sector classifier for commodities is being completed, and the first stage of a standardized documentation system has been introduced. A service for handling the sector level classifiers of technical and economic information and standardized documentation systems incorporated in the headquarter organization ("Soyuztorgsistema" All-Union Association) and the base organizations (the RIVTs of the Union Republic Ministries of Trade) has been created. The development and especially the use of applied program packages have expanded significantly. A series of documents of an organizational and scientific procedural nature has been recently developed. Among them are the Instructions on the Procedure for Considering, Coordinating and Approving Project Plan Documentation for ASUT's [automated trade control systems], Temporary Instructions on the Procedures for Bringing ASUT's on line, Procedure for Evaluating the Scientific and Technical Level an ASUT, Basic Principles for the Evaluation of the Economic Effectiveness of ASUT's, etc.

Serious and complex problems involving the further improvement of trade ASU efficiency confront the union republic ministires of trade, designers in the planning and technological organizations and computer centers as well as the organizations and enterprises for trade and public catering. It is necessary in the current five-year plan to reduce the average cost for setting up ASUT's

by 30 to 35%, and to bring the average timeframe for the creation of a single system down to 2.5 years. Significantly greater attention must be devoted to questions of the economic effectiveness of ASUT's and especially to the actual effectiveness, as well as boosting the efficiency and scientific and technical level of ASUT's through the application of mathematical economics techniques, data banks, multiple program and dialog data processing modes, video terminals for data preparation, minicomputers, and automated bookkeeping and invoicing machines. The quality of the preliminary project planning research, the active participation of the customer in the development of the technical specifications and plan documentation as well as in the introduction of the ASUT in accordance with the directives and standard setting documents must be improved, along with increased supervision and complete and timely preparation of the facilities being automated for the introduction of the ASUT's.

The Board of the USSR Ministry of Trade approved the coordinated plan for work on the design and further development of automated control systems and computer centers in trade during 1981-1985. In accordance with this plan, 41 systems are to be created in 11th Five-Year Plan in the Ukrainian SSR Ministry of Trade, 35 systems in the RSFSR Ministry of Trade, including 6 in Moscow and 8 in Leningrad, 13 in the Belorussian SSR Ministry of Trade, 12 each in the Moldavian SSR and Lithuanian SSR ministries of trade, and eight systems each in the Kazakh SSR and Latvian SSR ministries of trade.

Considering the special role played by wholesale trade in interrelationships with industry, in providing for an efficient commodity movement system and the effective utilization of commodity resources, the prerequisite are being created for the massive introduction of ASU's in wholesale trade in the 12th Five-Year Plan. The coordinated plan includes the creation of standard ASU project plans for all types of wholesale trade facilities. Initially, the plan provides for the preparation of documentation for the system for introduction at other facilities and the transmission of the standard software to the sector level library of algorithms and programs. In particuler, the "Beltoregsistma" institute will develop and introduce the "ASU-Torgodezhda" standard project plan at the Minsk oblast base, and the Moldavian Planning and Technological Office of the "Soyuztorgsistma" All-Union Association will develop and introduce the "ASU-Galanterera" standard project plan at the "Moldjalantereya" wholesale base and the "ASU-Obuv'torg" standard project plan at the "Armobuv'torg" wholesale base, etc.

For the first time, it is planned that a standard project plan will be developed within shortened timeframes and introduced at more than 12 facilities. This is the standard project plan for the automated dispatcher control and information systems for the management of municipal trade (or regional trade) being developed by the Central Planning and Technological Institute of the "Soyuztorgsistma" All-Union Association and the "RosASUTproyekt" republic level association. For the purpose of more effective utilization of the computers, the "Ukrtorgsistemotekhnika" republic level association is developing and will introduce standard project plans for automated data processing systems based on small computers for a retail trade enterprise or association) and for centralized bookkeeping.

In accordance with the comprehensive program of the USSR State Committee on Science and Technology, the "Soyuztorgsistema" All-Union Association in conjunction with the All-Union Scientific Research Institute for the Study of the People's Demand for Consumer Goods and Trade Conditions and the Main Computing and Data Processing Center of the USSR Ministry of Trade, as well as the republic level "RosASUTproyekt" and "Ukrtorgsistemotekhnika" associations are developing mathematical economic models and standard program software for the solution of sets of problems in trade management and the study and forecasting of demand by the populace, which will be introduced at the level of the USSR Ministry of Trade and the republic level ministries of trades. The successful resolution of this problem will promote the practical implementation of trade management using mathematical economics techniques and models. It is planned that the standard software being developed during this work will be turned over to the State Fund of Algorithms and Programs.

In 1982, the "Soyuztorgsistema" All-Union Association was included in the development of a long term specific set of programs of the State Committee on Science and Technology for the creation of the Statewide Information Retrieval and Processing System for Accounting, Planning and Control (OGAS), which is headed up by the All-Union Scientific Research Institute of Organization and Management Problems of the State Committee for Science and Technology. The "Soyuztorgsistema" All-Union Association in conjunction with the All-Union Scientific Research Institute for the Study of the People's Demand for Consumer Goods and Trade Conditions and the All-Union Scientific Research Institute of the Economics of Trade and Control Systems is to carry out the scientific and research efforts in the creation of the "State Trade" subsystem of the OGAS, which should provide for the interaction and interlinking of the work of trade management organs with statewide organs as well as those of related ministries and departments.

The participation in the creation of the OGAS, as well as the working out of the fundamentals for the design of the integrated automated trade control system, provided for by the Coordinated Plan, will make it possible to specify much more precisely, and with respect to a number of issues also determine the major trends and methods of automated trade control up to 1990 and even for the longer term.

The successful realization of the Coordinated Plan, which provides for the execution of more than 350 tasks, will render substantial assistance to the transition to a qualitatively new level of trade management, and to improving its quality and efficiency.

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DEVELOPMENT OF THE RSFSR GOSPLAN AUTOMATED SYSTEM FOR PLAN CALCULATIONS AND USE OF SMALL COMPUTERS

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[Article by N. S. Zenchenko (Moscow)]

[Excerpts] The 26th CPSU Congress stressed the need for systematic improvement in managing the national economy with regard to the increasing scales of production which have complicated economic relations and the demands of the scientific and technical revolution to make maximum use of the capabilities and advantages of the economics of mature socialism. "Solving the problems facing us," comrade L. I. Brezhnev noted in a Summary Report to the CPSU Central Committee, "and using the capabilities we have depend mainly on the level of direction of the national economy and the level of planning and management" [Materialy XXVI s"yezda KPSS [Materials of the 26th CPSU Congress], Moscow, Politizdat, 1981, p 49].

Using electronic computers and economic-mathematical models to automate management and planning processes has become a major direction in solving this problem in recent years. At the beginning of 1982, there were 340 management information systems (ASU) functioning in the RSFSR in enterprises and organizations of union republic subordination. Twice as many computers were installed in the years of the 10th Five-Year Plan as in the 9th while their capacity increased 3.5-fold. Management information systems are being developed in the RSFSR Gosplan, 53 republic ministries and departments, and 24 plan commissions in the autonomous republics, krays and oblasts. In addition to the large computers, small ones have recently begun to be used in the work of plan and administrative agencies.

In the RSFSR Gosplan, minicomputers appeared in 1975; these were four Italian IME-10003 computers. But the lack of hard disks limited the capability of handling plan problems associated with processing large information files. This circumstance led to the need of finding other models of computers without this deficiency. The WANG-2200 was such a computer. Factors leading to the selection of this computer system were: availability of the BASIC language suitable for data processing problems and direct-access storage on hard disks, the capability of interfacing with the Unified System of Computers and the positive experience in operating these machines in the USSR Gosplan and USSR Gossnab.

In the RSFSR Gosplan and NII ASU [Scientific Research Institute of Managment Information Systems] subordinate to it, there are a number of program facilities aimed at solving these problems. Thus, an interactive system for performing direct plan calculations on the WANG-2200 minicomputer has been developed and placed into operation; the "Proyekt" system, which has similar capabilities, is used in a number of RSFSR Gosplan departments; and a complex of programs has been compiled to support information transfer from the Unified System of Computers to minicomputers (this transfer was implemented in solving the large-scale problems on summing up the results of socialist competition throughout the RSFSR for 1980 and 1981 and others).

Measures are being taken to form complexes of Unified System and mini computers in connection with the development of a unified computer system for the RSFSR Gosplan. It will include a complex of hardware and software functioning within the framework of the specific technology for solving plan problems and based on the principles of distributed data processing. With that, the users, on the one hand, will have the capability of performing needed calculations on minicomputers and organizing local data bases to store needed information, and on the other hand, will be able to access a remote computer for calculations too complex for a minicomputer. The specific nature of the automated system for plan calculations causes the need for interaction between mini and Unified System computers; the chief difficulty here is interfacing computer systems with different architecture and software.

The pressing need for expanding production of small computers is also confirmed by a comparison of cost per hour of machine time: 100 rubles for the YeS 1040, 35 rubles for the SM-4, and about 7 rubles for a minicomputer.

Further introduction of minicomputers in the automated system for plan calculations to a considerable extent involves expanding the production of the Iskra-226 minicomputer which began in 1981, and developing the package of standard auxiliary and interactive systems of applications software for automating standard calculations. The efficiency of these computers in plan agencies will largely depend on equipping them with the necessary peripherals.

The Iskra-226 computer was put into production as the machine designed for economic planning tasks. This requires: large external memory, stably operating input/output units, interfaces to Unified System computers, and a sufficient number of displays. Not all these conditions have been met yet; in particular, the machines are being delivered without hard disks and this reduces substantially the possibility of using them.

Adopting the Unified System computers and the Iskra-226 minis as the main technical base in the automated system for plan calculations should not preclude the fundamental capabilities of using the SM series of small computers, primarily for the automated system of plan calculations in local plan agencies. There is now specific experience in operating with the SM-4 machines in the Moscow Oblast Planning Commission and with the SM-1800 in the Leningrad Oblast Planning Commission. Just as any other minicomputers, these require no special operating conditions and are not very difficult to master. Suffice it to say that 8 displays can be connected to the SM-4, 2 to the Iskra-226, but only 1 to the WANG-2200UR.

Of major importance are solving the problems of providing repair and preventive maintenance for minicomputers and setting up a system of centralized service for them. Since minicomputers are becoming an integral means of daily operations, their failure for even a brief period can disrupt the technology of the planning process and the schedules for submitting plans.

Intensified introduction of the entire complex of hardware into the practice of work in planning and administrative agencies will undoubtedly facilitate accomplishing the tasks set by the 26th CPSU Congress in the area of improving the economic mechanism in our country.

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AUTOMATED SYSTEM FOR PLAN CALCULATIONS--CURRENT STATUS AND DEVELOPMENTAL PROSPECTS

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[Article by V. V. Kossov (Moscow)]

[Text] The task of "introducing and making efficient use of the automated system for plan calculations" was set by the "basic directions for USSR economic and social development for 1981-1985 and the period to 1990." [Materialy XXVI s"yezda KPSS [Materials of the 26th CPSU Congress], Moscow, Politizdat, 1981, p 198]. This imposes high demands on the performance of all work related to the establishment and functioning of the ASPR [automated system for plan calculations].

In 1977-1978, the first phase of the USSR Gosplan and union republic gosplans ASPR was placed into operation, and in 1981, the results of the design and introduction of the system in the 10th Five-Year Plan were summed up. In the USSR Gosplan, union republic gosplans, and Moscow and Leningrad gorplans [city planning commissions], computers are used to handle about 10,000 economic planning tasks. The majority of the sections in the draft of the State Plan for the Economic and Social Development of the Country are developed by using the methods and facilities of the automated system for plan calculations.*

The main part of the problems solved within the ASPR is still operating off line. This, on the one hand, promotes display of initiative by the individual plan workers, but on the other, does not allow organizing information processing with the greatest effect since data exchange between problems is limited.

Efforts are now underway on the second phase of the system; its distinguishing feature is complexing and tying plan problems to be solved by using computers together. The main effect of this approach consists in considerable improvement in the relation between amounts of information input and output, which considerably expands the analytic capabilities of the system.

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* Problems of establishment of the ASPR and results of practical incorporation of the fundamental solutions of its concept on the design, staged introduction and functioning of the system in the process of drafting plans and organizing monitoring of the course of their fulfillment are covered in adequate detail in [1-4].

Efforts on the design and introduction of the ASPR in the 11th Five-Year Plan are concentrated in the following directions [1-4]:
current plan: design and introduction of information-computing complexes for balancing calculations of indicators of plans for production and capital construction and for providing the necessary resources for them;
five-year plan: design and introduction of the central complex of tasks (TsKZ) for determining the basic indicators of plans for USSR economic and social development and solving the problems of balancing them at the national economic level;
long-term plan: development of an integrated complex of balance calculations.

Generalization of the experience of the effort on the first phase of the ASPR and reequipment of computer centers with third-generation computers, primarily Unified System machines, led to the formation of the concept of the second phase of the ASPR, the essence of which consists in organizing an integrated electronic information processing system. Establishing data banks is becoming a task of paramount importance [5].

With the start of production by domestic industry of powerful models of computers in the Unified System series with high speed and considerable memory which allow connection of a large number of terminals and minicomputers to them, the capabilities of forming integrated data banks are emerging. Thus, establishing a distributed network of information processing which opens broad access to computers for plan workers is another important aspect determining the concept of the ASPR second phase. Practical construction of this network is a multiaspect problem requiring major scientific research and thorough design studies.

Considering the position of the USSR Gosplan in the system for managing the national economy, the initial stage in building the network is believed to be the unification of the powerful computers in the main computer center for the USSR Gosplan into a unified computing complex of machines with a large amount of common disk storage. This complex must become the technical base of the integrated data processing system based on using centralized information resources.

Ultimately, plans call for establishing a network which will directly include the computer centers in the union republic gosplans and afford access to the economic planning information resources in the ministries and departments. As the complex is put into operation, there will be changes in the organization and technology of its processing.

The majority of calculations are now performed in the batch mode. In this mode, the user is separated from the computer by the service of operators, which permits the best management of computer resources. But these achievements are offset by the user's uncertainty with regard to schedules for performance of his work. A qualitative enhancement of efficiency is afforded by the introduction of the real-time mode in which the user receives access to a computer by using a terminal. In the technology of operating in this mode, a number of fundamental aspects different from batch processing arise. After updating of source data, there is the capability of immediately performing calculations. Because calculations must be performed within minimal time (within several seconds) in the real-time mode, the program for running the job is built to involve not the entire information file, but just the area that was revised and to accordingly generate the final result only in the part shaped by the specified changes. In this case, the need arises for storing

on-line in the information resource not only the source data, but also the results of the calculations, and for constructing the program so that when the former is updated, the results obtained earlier are updated too. But, considering that the data being updated make up, as a rule, an insignificant part of the overall volume, a savings in machine resources used is achieved as well in addition to the efficiency of the calculations.

The real-time mode entails an increase in the requirement for direct-access units needed for on-line storage of the indicated information files, thanks to which the number of jobs handled increases, which requires computer processors with large capacities.

This process is implemented on the basis of combining individual Unified System series computers into a computer complex. To efficiently use the direct-access devices and processor capacity, placement of source data, results of calculations and programs is distributed on several machines. And during operation, the user need not concern himself with where his data, calculation results and programs are "physically" stored on one or another computer: He uses the same terminal and the same service (instruction set, "keys," capabilities) for running his jobs.

These requirements can be met by using the special hardware and software employed in setting up a computer complex. Individual computers are united by using the YeS 4061 channel-to-channel adapter, which supports data transfer between computers located close together at a rate of 1 mgb/sek [megabyte/second], and teleprocessing [TP] equipment for exchanging information between computers up to several thousands of kilometers apart at a rate of 48,000 baud.

The basis for the general computer systems software is the operating system similar to the MVS (Multiple Virtual System) and the OKA distributed data base with MSC (Multiple System Coupling) type facilities. With these facilities, a user can operate with any computer in the complex as if he were working with a single computer.

Even higher calculation efficiency can be achieved by connecting minicomputers as intelligent terminals to the computer complex [6]. The major purpose here is the organization on them of local information resources interrelated to the centralized, which will allow reducing the load on it during high-volume execution of plan calculations.

From the viewpoint of the nature of data processing in the departments of the USSR Gosplan and the union republic gosplans as well as of the ministry and department administrations, the overwhelming share of information is originated and deleted within the limits of the same structural subdivision. The volume of "external" information, both input and output, in relation to it is very small, which also makes expedient the organization of a distributed network for processing it. Naturally, setting up such a network is attended by the establishment of mandatory rules with respect to data processing conditions so that the information needed for other departments can be obtained without any special problems. This pertains to the principles for coding information, record standards and a number of other problems, the solution to which is needed so that each local unit is an element of a common network and not an isolated cell operating by its own rules.

Such a solution will enable the USSR Gosplan departments to form their own information banks by using computer hardware and to have the capability of working on-line with them and with other resources provided access is authorized. These functions can be implemented only on the basis of forming a distributed network.

By the end of the current five-year plan, each department of the USSR Gosplan will have one minicomputer as a minimum. To realize this goal, a clearly defined technical policy is being carried out for the development of production and organization of operation of the Iskra-226 computer. A major aspect of its use consists in performing local calculations while major information files are formed on the large computers in the Main Computer Center. Connecting the machines by communication lines and meeting the mandatory requirements for data processing conditions allows "polling" the minicomputers and timely readying of working files for them.

Terminals connected to large computers (the YeS 1045 has been chosen as the main machine for the USSR Gosplan Main Computer Center) are allocated to USSR Gosplan departments as a function of frequency of need for operating directly with the Main Computer Center. For this reason, equipping the departments with Iskra-226 computers and terminals off the YeS 1045 is considered a unified process and the most suitable hardware configuration is selected in each specific case. Thanks to this, within the framework of the effort on the introduction of the second phase of the ASPR, the physical capabilities are being provided for solving problems posed and access is being provided to computing facilities, and through them to data banks, for essentially all system users.

Under these conditions, a considerable change is taking place in the functions of economists working in the computer center. Up to now, one of their major tasks was to perform the role of a "translator" between the planning agency specialist and the computer. This pertains to organizing information acquisition, monitoring the results and presenting them. The new approach means that the new task is becoming development and evolution of the system while the user becomes directly responsible for operation of it.

Implementing this condition assumes training users to work directly with minicomputers which supplements regular enhancement of skills of plan workers (once every five years on the average for each of them). To this end, USSR Gosplan runs the Hogher Economic Courses and some of the specialists are taught in the USSR Academy of the National Economy (two-year course), while higher members attend the Institute for Management of the National Economy (for three months) that is part of the Academy.

An essential aspect of the introduction of the ASPR also involves organizing interaction between the USSR Gosplan, ministries, departments and union republic gosplans on the exchange of information [7], which is becoming a major factor in increasing the expeditiousness and validity of its processing and transfer.

As an example, one can cite the fact that about 11 tons of documents come into the USSR Gosplan annually; thus, you can imagine how much time has to be spent on "manually" searching for information needed.

In a technical respect, the problem is solved by exchanging information on machine media or sending data over communication lines. The first alternative is most

suitable for organizing interaction in the same city, while the second is more typical of intercity correspondence. But the complexities of solving this problem lie not at all in the technical sphere.

The planning system was formed, quite naturally, under the conditions of manual processing of information; a consequence of this is the wide use of standards and concepts specific to each department. From the human viewpoint, there is no difference at all between the two titles "Mineral Fertilizers" and "Fertilizers Mineral;" they are the same to a person. But for a computer, they are different, and a special program has to be written to identify one from the other. When you consider actual examples of just the nomenclature of products being produced and the large number of different ministries and departments, it becomes clear that just organization of recoding even automatically will require rather substantial resources and reduce system efficiency.

A nicer question is making changes, even if small, to generally accepted techniques of calculations which leads to differences in indicators. This is precisely the case in industrial production: To guarantee quality of the same product made in different places, there must be unity in the quality of raw materials and technology. Formally, this is no special problem. There are USSR Gosplan methodological directions [8] specifying the rules for defining the particular indicators used in planning. But in practice, one constantly runs into exceptions. There is only one way out of this situation: Perform the calculations under the conditions of the ASPR on computers only by using standard programs. This solution is important also from the viewpoint of the sharp reduction in costs for programming since otherwise, even in this program, various patches are made to adapt it to specific conditions. And the final result is the same: Each time, there must be an explanation as to what extent the value obtained is determined by the essence of the matter, and to what extent by the features of the local technique.

There are still a number of aspects reflecting the history of the formation of planning and hindering the shift of it to the course of electronic information processing. A real difficulty is that this effort is performed directly in a working system, by gradual restructuring of it and not alongside it. All the difficulties of reconstructing operating production are typical of this situation.

What has been said defines the general direction of the efforts on developing the ASPR in the current five-year plan, the aim of which is the direct inclusion of the plan worker in the operation of the system. A major aspect of this effort is the development of information processing technology inherent to the ASPR.

The experience gained to date allows asserting confidently that using computers for those tasks the plan worker handles manually is inefficient since it is costly and there is essentially no savings in time. There is an advantage only in the case when the tasks themselves and the technology for solving them are reinterpreted with regard to the capabilities offered by computers. A qualitative feature of planning is the capability of foreseeing events, which requires processing of large files of data. The consolidation that is performed to facilitate processing is inevitably attended by loss of a number of their useful properties. Therefore, irrespective of the separation of planned indicators by those estimated and those being approved in the ASPR, the entire file of them has to be processed, part of which then assume the form of plan quotas.

Experience shows that organizing the solution of plan problems on computers causes the need of increasing the amount of information required for these purposes by about two orders on the average compared to manual technology. The sources in organizing the effort are the standard forms adapted for processing information directly on computers. Their introduction is also important from the viewpoint of exchanging information on machine media since two data streams function in the process: The form goes for qualitative analysis to the plan worker and its machine version to the computer center. It follows from this that the forms should remain stable over at least the five-year period. Any changes to them require revising the program in all computer centers in the planning system. It is easy to imagine what this would cost. Finally, it is also important that automation is efficient only when the rather costly facility developed is used repeatedly. This is precisley why the sectors with mass production are distinguished by the highest level of automation.

The attempt to make a large number of changes to standard forms essentially for every annual plan is fraught with superfluous expenditures of resources and certain reduction in efficiency inevitable in changing programs. It should be noted that the software for operating with standard forms is an excessively rigid system that causes the need of revisions when they are changed.

The way out of this situation is to build data banks with a system of indicators and generation of forms upon requests of a user. As was stated earlier, there are two flows of information in electronic technology of information processing: to the plan worker and the computer center. Such organization of work is possible in the case when the volume of incoming data is visible for the executive. A sharp increase in it makes such organization problematic. The predominant situation (and the further, the more so) will be the exchange of information directly between computer centers.

Take for example the centralized calculations on the demand for metal for machine building products [9]. To meet it, information on the plan norms for consumption of metal (about 30 types) pertaining to the year preceding that being planned is gathered for about 10,000 types and groups of machines and equipment in the USSR Gosplan Main Computer Center. It is compared with that already in the system by using a sort of "electronic sieve" through which pass all the norms meeting the requirements previously generated, while the rest are delayed and go along with an explanation of the causes of delay to a plan worker for substantive analysis. Since about 400,000 indicators are stored in the system, it would be physically impossible to perform this work without computers.

The task of the plan worker, with the invitation of the specialists in the ministries and USSR Gosplan departments concerned with the appropriate norm, is to consider it for the essence, make a decision and communicate it to the Main Computer Center for input to the data file, which after its creation allows performing analysis of the demand for metal by the nomenclature being correlated; he also has to evaluate the effect of structural changes and fulfillment of the quotas for economy and make a number of other calculations related to the problem of specific material consumption. The final result of the calculations is the definition of demand for the metal for the production program. Calculated similarly is the demand for it for maintenance and repair needs and capital construction. The results obtained are the basis for structuring the balance for the metal and generating plans for distribution of it.

The introduction of the limit of physical inputs in a number of indicators being planned poses new problems for further development of the system. They involve solving two problems. The first is the gradual increase in the total number of resources according to which a centralized calculation of demand for output is made to embrace by normalization all major types of them. The second is the formation of the total amount of input in monetary terms by using pricing data. The importance of the latter problem is shaped by the current lack of an adequately reliable relation between calculations on demand for output and substantiations for reduction in production cost. This, in particular, does not allow analyzing reduction in production cost by factors of economy of the corresponding resources. The point here is not just to supplement calculation of demand with the price of a particular material. Automation already offers rather powerful facilities now for solving this problem. Much more complicated is covering by normalization the various areas of utilization of the resource, and the main problem here is to raise the standarding work to a significantly higher level compared to the current.

Available information on norms for consumption of output is the source for generating data for larger calculations, particularly for the natural-value intersector balance.

Here is a good example to illustrate the basic principles of the ASPR: The information once input in some way passes through into ever more numerous calculations and that is why the volume of indicators processed in an automated system is manifoldly greater than that handled in manual technology of planning. A unique efficiency factor for the ASPR is the data multiplication factor which is the ratio of output to input information. But one should not be carried away with this criterion. Thanks to technical capabilities of existing facilities, its value can be raised sharply and an information stream formed with which the user simply cannot cope. But to resolve in advance what queries and profiles of data processing must be provided for in the ASPR is essentially impossible because of the dynamics of economics: Some problems disappear while others emerge. For this reason, the best solution lies in offering the user himself the capability of operating directly with the system, and this is achieved by creating a distributed network.

Centralized calculation of the demand for output of metal is one of the examples of technological solutions meeting the requirements of the ASPR. Even more illustrative in this respect is the Unified System for Comprehensive Planning of Capital Construction (YeSPKS) which is under development and which covers construction projects: everything over the limit, on complete import equipment and the CEMA. This system will be monitoring several thousands of construction projects from design to commissioning of them. A card on each of them, developed for input of information into computers, will allow obtaining all documents pertaining to the planning and financing of capital construction. The overall file of indicators contains about 16 million. Processing it under the conditions of a distributed network presupposes practically full utilization of YeS 1045 type computer resources.

These examples describe the features of the technology used in the second phase of the ASPR. It makes certain changes to the approach tp forming new problems. It is most evident in the central complex of tasks (TsKZ) created for the purposes of five-year planning.

The essence of the central complex of tasks [10, 11] consists in the fact that it orients all system developers and users to solving fixed tasks by each group of USSR Gosplan departments (sector, balance, consolidation) to afford a unified front of efforts on the five-year plan. Each department performs a certain amount of it, but the information contained in the tasks introduced must be used extensively in the automated mode in developing all major sections of the plan.

At the level of the sector department, among the mandatory are calculations for the production plan in physical and value terms, as well as the sector demand for physical resources and capital investment. The work of the balance and consolidation departments is organized in a natural way on the base of this information. A number of these tasks have been solved now for many years, but not by all sector departments.

Up to now, it has been a question of various organizational questions related to ASPR introduction. They have to be solved to create data bases to be used as the basis not only for opening broad possibilities to exploit plan calculations typical to planning, but also to substantially facilitate introduction of model calculations considerably more complex in their nature.

One can cite as an example analytic developments on the base of major intersector balances in value terms. For several years, the Administration for the Balance of the National Economy in the USSR Central Statistical Administration, in accordance with the program coordinated with the USSR Gosplan, has performed the work on structuring of the dynamic series, elements of which are the intersector balances in a profile of 18 sectors in teh sphere of physical production. The information obtained has undergone additional checking at the USSR Gosplan Main Computer Center from the viewpoint of logicalness of proportions and trends in economic development. The fact is that the accounting intersector balances are structured in current prices of final consumption, according to which price indexes are lacking, and in addition, in 20 years (such is the duration of the dynamic series), several changes have occurred in the composition of the sectors. All this also determines the real complexity of the effort on converting indicators in question into comparable prices. These balances are a major source of information in designing the dynamic intersector model of the development of the country's national economy which is used as the traditional tool in calculations for drafting plans for the five-year and longer periods.

Development of the country's Food Program required study of a wide range of questions related to determining the place of the agroindustrial complex (APK) in the national economic system. Within the bounds of these efforts in particular, the contribution of each sector in the national economy and industry to meeting the country's demand for the output of the agroindustrial complex was computed. Considered was the final consumption of the output of agriculture and the food (including fish) and light industry in the part produced from raw agricultural materials.

The calculations have allowed identifying direct and indirect utilization of the products of heavy industry, transportation services and capital investment in the production sphere to meet the country's final demand for agroindustrial complex output. The calculations were possible because there was comparable information for a long period of time. Without this, in the best case one could have obtained an illustration for some individual year.

This example reveals a major aspect of the effort with models under ASPR conditions [12]: Of practical interest are only those in which the information is provided by regulation, tracked by the system and wholly reliable. For this reason, the main focus in studies by modeling in science, from our viewpoint, must be shifted from quests for original model solutions to discovering the processes flowing in the national economy based on prescribed data.

In evaluating the general status of development and application of models in the ASPR, one rather striking feature can be noticed. Most advanced is modeling of the production sphere, from the individual sectors to the economy as a whole. Significantly more poorly developed are efforts pertaining to the nonproduction sphere and social questions; in this case, as a rule, the relation with the growth of the entire national economy is not tracked. The nonproduction sphere itself is represented in consolidated economic calculations only from the aspect of inputs (i.e., what resources the country directs to it is known). Meanwhile, progress, say, in health and reduction in the rate of illness have a direct effect on the resources of work time and labor productivity, and through them, on all production.

In principle, people with considerable experience and knowledge can in many cases make rather efficient decisions concerning the development of the economy, and without using computers. True, this is valid only in those cases when the situation is habitual. The advantage of the model approach is precisely that it allows the ordinary specialist to make fine decisions since the relations included in the model are described and checked by specialists more competent in the given area. But for now, model calculations account for only 20 percent of all information processing.

Special mention should be made of the ASPR at the republic level [13-15]. At present, all computer centers in the union republic gosplans are equipped with Unified System series computers, operation of minicomputers has begun, and the general system supporting facilities are being actively assimilated. One should mention the great effort in this area by the UkSSR Gosplan, the lead developer of the ASPR for union republics with the oblast division. About 800 tasks for 27 functional subsystems were placed into operation in this republic from 1978 through 1980. Considerable progress has also been made in the RSFSR Gosplan where about 900 tasks for 37 functional subsystems were put in operation in the same period; the majority of them are handled by minicomputers and thus, they can be widely circulated for application in union republic gosplans [16].

The main problem in ASPR development at the republic level is in forming calculation complexes with regard to the features and needs of planning for each republic, as well as in organizing the interface between the tasks handled by them and the USSR Gosplan ASPR.

The work on developing the ASPR in our country is meeting with a warm response in the CEMA countries. As the coordinating meeting held in Prague in April 1982 showed, the methodological materials on developing the ASPR are well known and an exchange of experience in this area was organized. Naturally, the features of planning in each country also determine the specifics of the systems being developed.

But despite the differences in the nature of information processing, the common nature of the social system determines the uniformity in the fundamental approach to organizing the system of plan calculations. Cooperation in this area makes it possible to better understand the features and outlook of the individual solutions and to make the progress achieved in one country the common property of the whole socialist community.

The introduction of the ASPR and the direct use of it by plan agency employees primarily to evaluate the consequences of solutions being prepared at all stages in drafting a plan is an important link in the entire complex of measures on improving planning.

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PROBLEM OF VISUALIZING INFORMATION AND DIGITAL PROCESSING OF IMAGES

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[Text] Undeviating growth of the volume of information obtained in the course of contemporary scientific experiment has long placed before researchers the problem of seeing the results of experiment as a single whole. It is a matter of dealing with masses of millions of measurements and of not losing in separate numbers the total picture of the result. The "picture" in the given context is an accidental metaphor: the visual channel of perception of people is distinguished by very great carrying capacity in comparison with other sensory organs, and so the depiction of information in the form of "pictures" makes it very accessible for effective perception and subsequent analysis.

From the cited measurements the progress of technical means of measurement is to a considerable degree directed toward the creation of the possibility of perceiving what earlier was inaccessible for visual perception. In particular this goal is served by equipment which uses invisible radiation (radio waves, X-rays, etc). However, it would be wrong to think that the problem of visualizing information is reduced to only the registration of radiation invisible to the eye. Also urgent is a picturing system--a means which would permit forming images from the radiation fluxes (particles) which move from an object or, what is especially important, from information with reference to spatial distribution of the mentioned fluxes. The latter means that in the role of depiction an information system can appear which creates depiction of an object through the processing of information at first registered in a somewhat different form.

A very simple example of this type can be the recreation of an image through information registered in the form of a hologram. In a typical example the image is constructed in a far more complicated manner--for example, the task of recreating the structure of a crystal through roentgenograms.

The processing of output information necessary for image construction is accomplished by special means. At times they are accomplished simply (as in the case with a hologram), but for the most part a universal approach is needed, which can only be a system of digital processing of images. Therefore problem of visualization is clearly connected with the digital processing of images. The present article

is devoted to questions of the visualization of various types of information. The results were obtained in the process of carrying out work using a system of digital processes of images created in the Institute of Radiophysics and Electronics of the Ukrainian SSR Academy of Sciences (1).

Forms of visual presentation of images

In many cases the information which must be visualized has the character of a function of two variables, the values of which are a number or an aggregate of numbers. Among the possible methods of representing functions, it is natural to distinguish two- and three-dimensional. In both those cases the region of change of argument is reflected on a certain region of the coordinate plane. The values of the function represent the clearness, the color or their visual indication. In the three-dimensional case one component of the function can represent the surface in a space, the height of which above the coordinate plane equals the value of the function. The rest of the function components reflect on that surface just as it is done in the two-dimensional case on the plane of the image. It is not natural to give the height the same components of the function that are given to the simple form of the object (an example can be hypsometric models of the surfaces of planets).

A simple method of depicting the relief of a function is a three-dimensional graph (a block diagram). Let the method consist of a structure on a plane on an axonometric projection of a discrete network of points (or lines) laid on a three-dimensional space. Depiction in the form of a tri-dimensional graph is a universal method useful for any kind of adequate measure of smooth linear functions of two variables. However, it should not be forgotten that in some cases one has to deal with not an abstract function but an object accessible for direct visual perception. Therefore a more adequate means of depiction will be ordinary photography or depiction which imitates photography under appropriate survey conditions.

The set of values of functions which bear information which must be visualized can continuously reflect on a set of values of brightness or color. Such images are characterized by considerable visibility., thanks to obviously good organization of the values of brightness or color. It should be taken into account that with such a method and by means of brightness a single component of a function can be depicted, and by means of color, not more than three. It is useful to combine continuous coding with brightness or color for depiction of a system of isolines, which fixes certain values of investigated characteristics. In that case the isolines are readily read and the depiction is not only well perceived visually but it contains quantitative information.

Another method of representation consists in discrete coding of values of functions of brightness or color. In that case the principles of limitation of correlation between the proportions of the represented are not imposed. A practical limitation, however, is the number of gradations of brightness or color, which at the given noise level can be visually different. The citing of the observation conforms to the case of perception of a function of continuous coding connected with an isoline system. If the noise limitation does not permit giving the necessary number of discrete values of the functions, a more complicated coding is used during which one case of the function corresponds to more than one element (possibly an entire fragment) of an image. Besides, the visual signs by means of which coding can be done adewuately are different kinds of strokes, symbolic markings, etc. Thus, in cartography different kinds of strokes have already been used for a long time, strokes which differ in

color and structure. In spite of the wide possibilities of discrete coding, the absence of natural order worsens the effectiveness of visual perception of images in comparison with continuous coding.

Almost all the above-mentioned methods capable of visual representation of information have long been used in practice of scientific research. However, they all are too labor-consuming to realize and it will not be an exaggeration to say that with the development of digital technology all these methods will actually be born again.

Possibilities of digital processing of images

The idea of automatic processing of information in digital form according to a given algorithm arose even in the last century. It was suggested by the English mathematician Bebbidge. The effective realization of the idea became possible only in the 1940's, when the technical base appeared for computer construction. At that time the forgotten idea of Bebbidge was newly discovered by von Neumann.

Digital processimg of images is real when the potential of calculating machines reaches the level necessary to introduce the idea in the computer memory and process it in an acceptable time. This means that the computer must contain masses of 10^6 or more numbers and have a speed of 10^5 or more operations per second. Since it is not easy to preserve such a volume in the operative memory of a computer, the machine must be capable of exchanging data as rapidly as possible (10^5 or more numbers per second).

The digital processing of ideas as a powerful method of solving many scientific and practical problems is being intensively developed in a number of countries. Thus, in the Institute of Radiophysics and Electronics of the Ukrainian SSR Academy of Sciences work in this direction was started at the end of the 1960's. In the course of that work a system was created for the digital processsing of ideas exclusively on the basis of our country's possession of serial production or specially developed in the IRE (1). The system has a central processor, the above-mentioned instruments on magnetic disks and magnetic tapes, means of operator dialog with the system and a device for image input and output. In the system devices for image input and output of two types are used: rapid--with scanning of ideas by means of a cathode-ray tube; and slower, a more precise device which uses mechanical scanning. The mentioned device permits loading and unloading black-and-white and colored photographic images with definition of 1024 x 1280 elements and amplitude quantization on 256 or 2048 levels, uniformly distributed on a linear or logarithmic scale. The system functions under the administration of a specially developed operational system, oriented toward image processing.

Digital methods open up practically unlimited possibilities. These completely repay expenditures on the creation of corresponding equipment. The tasks of digital image processing can be divided into three types:

1) transformation of images when the input and output data are images:

2) analysis of images when the output is an image and the result is itself certain characteristics of the image of the object;

3) representation of information when the output is certain information that does not have the character of an image, and the result is images.

We will present some types of examples of tasks of image processing.

In the process of acquiring or transmitting along a channel the connections of an image undergo different deformations of an accidental (noise) and regular (washing away, geometric distortion) character. Often the initial image of the form of information reveals itself in a complicated manner for the perception of visual apparatus by people (low contrast, frequency deformation). Often the information happens to be separated with a large series of information, each bit of which is not informative enough (an image with a high noise level, heat interferograms, etc). This evokes a need for image filtration, the idea of which arose long ago as a result of natural sepansion of methods of radio engineering of two-dimensional signals. Tasks of this type belong, according to our classification, to the first type. They are encountered in astronomy, space research, medical diagnosis, industrial flaw-detection, etc.

Often a need arises to investigate the correlation characteristics of two or more images. They can be a series of images of objects which vary in time, or images of a stationary object which reflect the distribution of its various characteristics. The characteristics of the correlation dependences of images are investigated, for example, being two-dimensional or multi-dimensional histograms of the distributions of parameters of the devices. When the task is limited to investigations of histograms (the values of the correlation coefficient, registration of regression equations, etc), it belongs to another type in our classifiication. It is possible, therefore, to reflect the results of analysis of the correlation connection in the coordinate system of output images. Let us say, to depict on one of the output images the distribution of points which find themselves in the region of condensation on histograms (clusters). There we turn to tasks of the first type. Investigation of various correlations is one of the basic methods of learning the properties of nature. Therefore there is no need to enumerate the branches of science and technology where problems of the correlation type have to be solved.

Quite often it is useful to change the conciseness of the output image. More often it is required to increase the informativeness, attracting additional information (not obligatorily given in the form of an image). And sometimes the informational loading of images is so high that they require generalization. Then arise tasks of visualizing information, the direct perception of which is made difficult as a result of an excess of other information (for example, in geology during morphological deciphering of photographs of landscapes).

In the natural sciences there are many tasks in which it is desired or even necessary to present data which do not have the character of images, in visual form (the third type of our classification). This first of all uses experimental data. Use of such a method becomes most fruitful, perhaps, in chemistry and molecular biology. Visualization of information can also be extremely useful for making more graphic some positions of formal theories (quantum mechanics, general theory of relativity, etc). It can produce a stimulating effect on the process of intuitive search for new solutions. Well-known examples of the creation on a computer of films which demonstrate a model of processes of the creation of galaxies have been seen.

This is a short and, of course, far from complete account of the possibilities of use of digital processing of images. Below are presented specific examples which characterize those possibilities in greater detail.

Visualization of radar data

Let us examine the results of processing and the future visualization of radar data on the surface of Venus, obtained by the space apparatus "Pioneer-Venus." These data, in the form of maps, were transmitted by the U.S. NASA to the USSR Academy of Sciences for independent analysis. The work is one of the elements of collaboration between scientists of the USSR and the USA in the study of cosmic space. The organizational aspect of the collaboration is accomplished by RADIO INTTERKOSMOS of the USSR Academy of Sciences and NASA of the USA. The data are processed in the Institute of Radiophysics and Electronics of the Ukrainian SSR Academy of Sciences jointly with the Laboratory of Comparative Planetology of the Geochemical Institute, USSR Academy of Sciences, and also the Section of Physics of the Moon and Planets, Astronomical Observatory, Khar'kov State University.

Output radar data. Global and regional investigations of the surface of Venus are made only by radar methods through the presence of a whole bed of clouds which surround the planet. Radar measurement of the surface of Venus is done by ground radiotelescopes and by means of space methods. The first radio sounding of the surface of Venus from space was made by the Soviet Robot Space Station (RSS) Venus-4 in 1967. The latest information about the relief of Venus was obtained by means of an on-board locator of the "Pioneer-Venus-1" space apparatus in 1979-1980. The radar of that space apparatus worked alternately in regimes of height measurement and measurement of intensity of a reflected signal (wavelength--17 cm). As a result of those measurements an altimetric map was constructed, maps of roughness of the decameter and centimeter scales and maps of variations of the coefficient of reflected radio waves (2,3).

Our attention was attracted by two regions of the surface of Venus. The first of them (Beta) is limited on the maps to latitudes -15° and +40° and longitudes of 250°... and 330°... The Soviet Robot Space Stations "Venus-9-14" made landings in those regions. In the same place one can expect events of contemporary volcanism. Another region (Earth Ishtar) is limited on maps to latitudes of 45°...+73° and longitudes of 315°...30°. This is one of the most puzzling regions in a geological respect. Just here is the Maxwell mountain massif, the highest on Venus, with a height more than 12 km above the zero level.

Our task was to investigate the correlation of some radar parameters which characterize destructive features of structures of the surface of Venus, and the development of methods of presenting data in a form convenient for future analysis (4.5).

Digital processing of radar data. In the first stage of processing the distribution of heights on a section, represented by a family of horizontals interpolating a function, which always has another derivative and acquires on the horizontal the values indicated on the map. Then the planned image of the relief of the surface was modelled during slanted illumination. In a future stage the planned image was transformed to an axonometric projection on the hypothesis that the surface scatters light according to Lambert's law.

On Fig 1 and 2 are given synthesized images of the regions Beta and Earth Ishtar respectively (view from southeast, illumination from southwest). The height of the source of parallel luminous rays over the horizon is almost 1/40 radian. For greater clarity the distances along the vertical are about 100 times larger than along the horizontal.

Fig 1. Panorama of region Beta, almost 5000 km^2 in size. Distances along the vertical are about 100 times larger than along the horizontal.

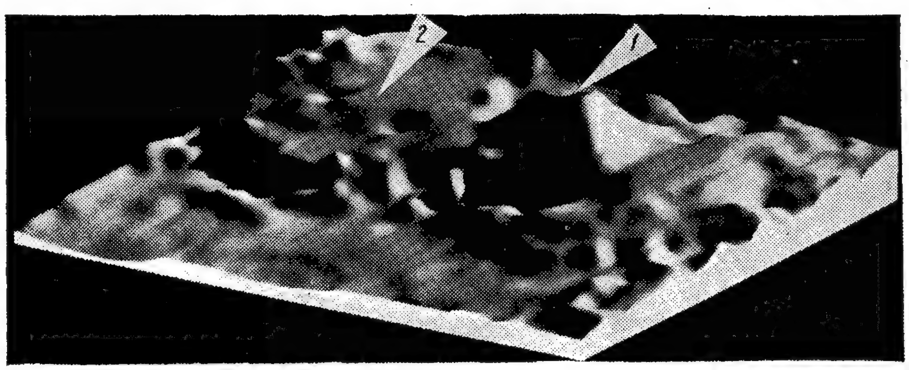

Fig 2. Panorama of region Earth Ishtar. Arrows show Maxwell Mountains (1) and Lakshmi plateau (2)

Interpolated height distribution also was used in constructing maps of regional slopes of the surface. For the construction of such maps, on each point of the corresponding images is calculated the modulus of the height gradients, averaged on a base of 280 km. The maps of regional slopes for the investigated regions are presented on Figs 3 and 4 in a hatched variant.

The calculated values of the height gradient modulus were used to investigate their correlation with the height distribution. The corresponding diagram for the Beta region is given on Fig 5 and for the Earth Ishtar region on Fig 6. Maps os the types of localities, which correspond to the performed analysis of diagrams, are presented on Figs 7 and 8. For Earth Ishtar the breakdown of the diagram was accomplished with a lattice (Fig 8). The corresponding map is a simultaneous coarsened distribution of heights and height gradients. For the Beta region clusters are distinguished on the diagram (Fig 7). A map of the type of locality, which corresponds to separation of clusters, is a distribution of regions with a certain predominance of a combination of research parameters.

The structure of images with a little different parameters of axonometric projections permitted synthesizing stereo-panograms of the surface of an investigated region. On Figs 9 and 10 are shown appropriate stereo-panograms of the surfaces of the regions Beta and Earth Ishtar. On the panoramas as thematic loadings of a color code is shown the distribution of degrees of porosity in the decameter scale.

Analysis of the obtained results. Clearly visible on the images of region Beat (Figs 1 and 9) are three types of locality of hilly levels on which are laid lower levels on the northeast and numerous elevations, among which the most expressed is the Beta mountain massif. The angularity of outlines and the presence of graven-like lineaments to testify to the important role of tectonic phenomena in the formation of the mentioned mountain structure. According to the data (2,3), the region of Beta experienced tectonic volcanic activization on a large zone of meridional extension. Coordinated with it is the appearance of the maps of slopes (Fig 3), two-parameter maps (Fig 7) and stereo-panoramas (Fig 9). For roughness in the decametric scale the investigated region also has certain distinctive features: strongly comparable and slightly rough sections are disposed in all the main types of geologic provinces of Venus (Fig 9).

On obtained images of Earth Ishtar (Figs 2 and 10) is well read the tectonic nature of the mentioned formation. The Lakshmi plateau in the western section of Earth Ishtar, with a level relief of the surface and moderate roughness in the decametric range (Fig 10), recalls the southern plain of low hypsomotive levels adjoining this and, possibly, a slightly elevated block of those levels. The Maxwell mountain massif, which occupies the central part of Earth Ishtar, clearly is different in its relief and obviously in the character of the processes which created it from the Maxwell portion of Earth Ishtar, disposed to the east, where it is possible to dispose at least three directions probably tectonic in nature (Figs 4 and 8), which testifies to a complicated geological history of the locality.

The presence of a two-valued correlation between height and regional slopes of the locality is characteristic both for the region Beta and for Earth Ishtar. On the average at small values of heights the slopes increase with increase in height, and upon further increase are reduced (Figs 5 and 6). For different sections the positions of two-valued correlation series are little different, which also is reflected on maps of types of localities (Figs 7 and 8).

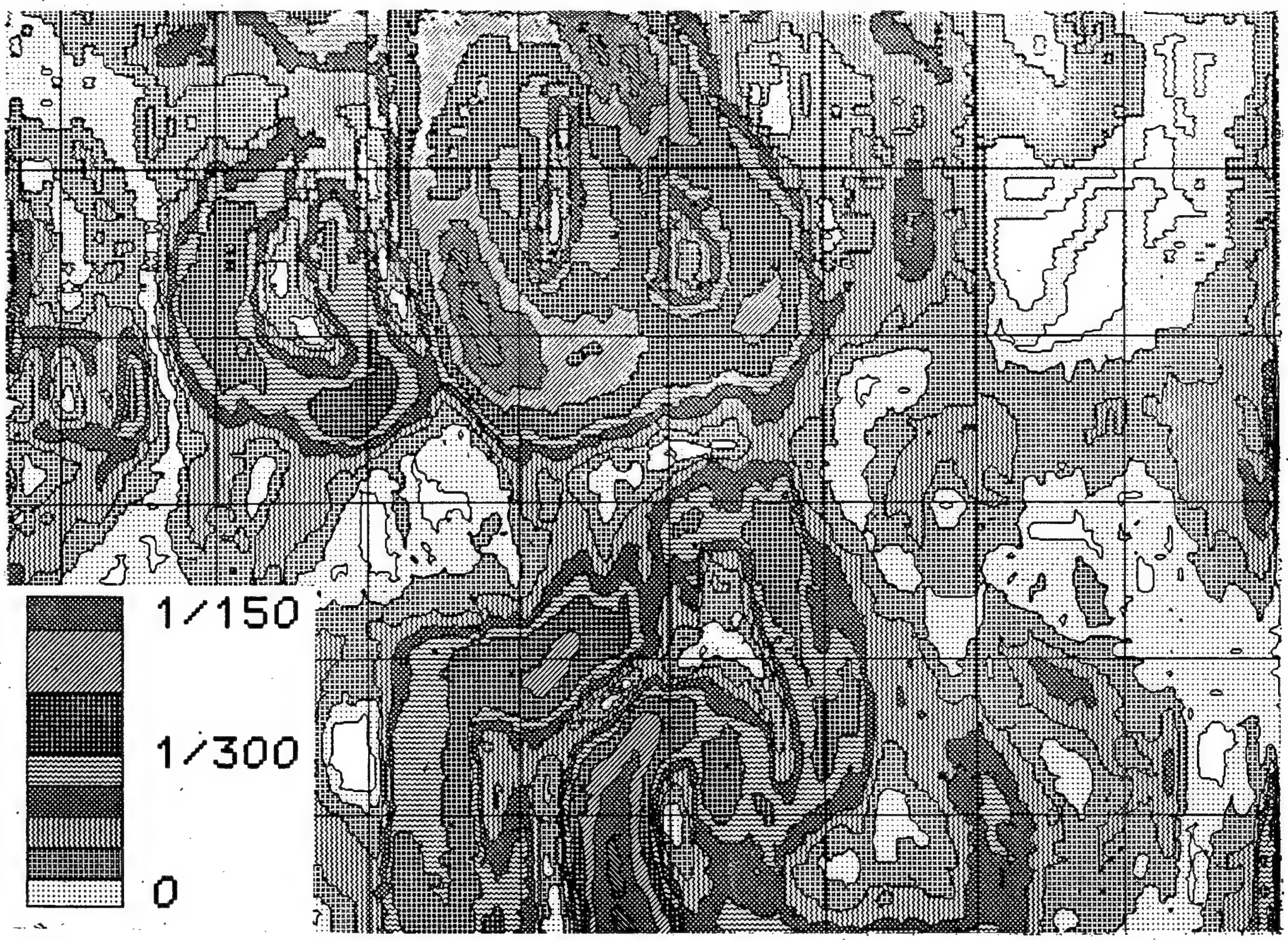

Fig 3. Map of regional slopes (modulus of height gradient) on basis of 280 km for the Beta region. Scale of slopes shown on map.

Structure of images of spatial structure of biological macromolecules

To understand the processes which occur in the living organism it is necessary to clearly picture the molecular mechanism of the interaction of spatially organized methods which are now being developed, a number of which can give information about the spatial structure of biopolymers and possible forms of its manifestation during the functioning of biological objects. A very powerful method is X-ray structure analysis of biopolymers, which makes it possible to obtain detailed information about the distribution of all the atoms (except hydrogen) in macromolecules of proteins and nucleic acids. For the exchange of information obtained from this direction of investigations in various laboratories of the world an international data bank has been created. The data have been widely used in biophysical institutes of many countries, including the USSR (Institute of Protein, USSR Academy of Sciences, Institute of Molecular Biology, USSR Academy of Sciences, etc).

A necessary stage for the effective use of X-ray structural data is the construction of spatial models of investigated molecules. Usually those models are mechanical. They are labor-intensive and inconvenient to use. Those disadvantages are eliminated to a considerable degree by a spatial model constructed with the use of a computer. In that case it is possible not only to readily manipulate the object but also to make a mathematical information analysis with automatic withdrawal of the final result in the form of optimum spatial models. Especially effective is the presentation of images of spatial models in the form of stereoscopic pairs or sets of stereoscopic pairs.

Shown on Fig 11 are stereoscopic images of the protein ribonuclease, constructed according to data of (6) with differentiations in several angstroms. Ribonuclease is composed of one polypeptide chain which contains 124 amino acid residues. Its spatial structure is supported by 4 disulfide bridges and non-covalent bonds. A very well known property of ribonuclease is ability to renew the native spatial conformation after the influence of various active agents. The activity of ribonuclease is connected with the absorption of molecules of substrate in the close active center and conditioned by rough spatial distribution of catalytically active amino acid residues.

On Fig 11 in various colors are shown the types of atoms which belong to individual functional groups of proteins. On Fig 12 is presented a fragment of a stereo-formed molecule of ribonuclease with the separation of hydrate centers.

Investigation of the hydration of biopolymers is one of the important problems of biophysics. All the biological processes in living organisms occur in an aqueous environment which is not passive but enters the structure of biopolymers and to a considerable degree determines their functional properties. The used method of dielectrometry developed in the IRE of the UkSSR Academy of Sciences permitted for the first time making a distribution by types of structural organization of the water connected by a biopolymer. To develop a suitable method it is necessary to analyze the structure of biopolymers according to algorithms making it possible to designate the potential of the place the water is visualized. Such a type of analysis is practically impossible without visualizing data regarding structure.

The hydrate center on which is shown an arrow 1 (Fig 12) is composed of a group of atoms of amino acid residues. It is sterically accessible to water molecules and

can be the place of formation of the water associate. The center designated by arrow 2 is inaccessible to water molecules, since it formed an intramolecular bond with the NH group of the amino acid residue.

The method of digital processing of images can be effectively used for visualizing bio-macromolecules or complexes of them during the solution of many problems of molecular biophysics, let us say, in the representation of fragment-substrate interactions and models of antigen-antibody interactions or for visualization of macromolecules and fragments of them during investigation of molecular aspects of a problem of identification. The method also can be useful in solving practical problems, for example, in finding out the molecular principles of medicinal preparations.

Visualization of some processes in quantum-mechanical systems

In the process of identifying human nature there has been specialization of the reception of investigation, which led to the formation of two main methods of investigation--theoretical and experimental. Such a division, however, is to a certain degree conventional. Let us say, during the solution of problems of theoretical physics wide use is made of a mental experiment, the values of which were first discovered by Albert Einstein. In the main this experiment belongs to experiments performed, not with the object of investigation, but with his model. In it the main attention is given, not to an abstract mathematical model of an object, but to the visual representation of it. The effectiveness of such a method of investigation can be enhanced by intensive methods of machine graphics to construct images which illustrate the essence of the problem being studied.

Let us explain what has been said by an example from quantum mechanics. There exists the thinking that phenomena reflected in quantum-mechanical systems are not amenable to visual representation. This is partly true, and so not often optical magnification becomes possible if the visible properties do not contradict the laws of quantum mechanics.

An optical model was constructed of the process of irradiation and absorption of electromagnetic energy of a water-resembling atom. For the described system, composed of an atom and a plane monochromatic circular polarized wave, we take advantage of very classic approximations in which the atom is described by both quantum and electromagnetic chemistry and by classic subsystems. We will take into account that the wave frequency closely corresponds to the difference between the energies of the atoms in mainly the first excited state, and its phase is equal to zero t = 0.

Let ψ_0 and ψ_1 be the vectors of the main and excited states of the atom. State ψ_1 is characterized by the values $\ell = 1$ and $m = 1$ (ℓ and m are the quantum numbers). The Hamiltonian system is the sum of the main item $\hat{H}$ and weak drilling $\hat{H}_1$, conditioned by the influence of the spectromagnetic wave and proportional to its amplitude A. The vectors ψ_0 and ψ_1 are the proper vectors of the operator $\hat{H}$ with the considerable values $h\omega_0$ and $h\omega_1$. If in the first observation you seek equations of the Shroedinger solution, which is described by a system with the form:

$$\psi(t) = C_0\psi_0 e^{i\omega_0 t} + C_1\psi_1 e^{i\omega t}, \quad (1)$$

for the coefficients C_0 and C_1 is obtained the system of equations

$$\frac{dC_0}{dt} = \Omega C_1 \qquad (2)$$

$$\frac{dC_1}{dt} = \Omega C_0, \qquad (3)$$

where Ω is proportional to the wave amplitude and matrix element M of the transition between the states ψ_0 and ψ_1, for greater precision, at t= 0 the state of the system was ψ_0, that is, $C_0 = 1$, $C_1 = 0$. Then the solutions of equations (2) and (3) have the form:

$$C_0 = \cos\Omega t, \quad C_1 = \sin\Omega t.$$

It can readily be recalled that here we have the right with this very simple example, if the scope of states of the system is a plane. The vector of state system initially directed along the axis ψ_0 is uniformly turned in this plane around the beginning of the coordinates with an angular velocity proportional to the amplitude of the falling wave. In this process the vector passes through parts ψ_0 and ψ_1 of the state in succession. The mixing of the states corresponds to the stages of engulfment and constrained irradiation.

Let us turn now to the shape of the wave function of the atom in the coordinate representation. Let us consider it only in the plane z = 0. On the basis of that the state $\psi_0(x,y)$ is real; in the excited state $\psi_1(x,y)$ is proportional to $e^{i\phi}$, where ϕ is the amplitude angle in the polar system of coordinates. In the literature of quantum mechanics the electronic density in the atom often becomes the object of a visual image, but only by methods of machine graphics, with the use of color coding can form not only molecules but also the phase of a wave function. On Fig 13 (a,b) are visible images of a water-resembling atom in the stationary states ψ_0 and ψ_1 respectively. On Fig 13b is shown the same atom in the mixed state with an equal weight $(C_0)^2$ and $(C_1)^2$. The dynamics of the process, unfortunately, cannot be demonstrated without using motion pictures, and we are trying to describe it with words.

At t = 0 the atom is such as on Fig 13a. With time appears mixing of the state ψ_1 which is manifested in displacement of the center of gravity of an electron cloud in relation to the start of the coordinates and an imaginary component appears in a wave function. On Fig 13 b this corresponds to the deviation from the purely green color at the side of the cold and warm tones. These deviations achieve a maximum in the direction perpendicular to the straight line which unites the center of gravity of the cloud and the start of the coordinates. In that case the electronic wave is turned as a single body from the frequency of the falling wave ω in the direction of turning the vector of exertion E. The orientation of the wave E is such that the dipole moment of the atom perpendicular to E and the electric field of the wave performs work on it. This causes increase of the energy of the atom and of the weight of the state ψ_1. The process achieves the greatest speed in the state depicted on Fig 13c. Further evolution of state leads to reduction of the dipole moment of the atom during the same orientation of it in relation to the field of the wave, which is accomplished by achieving the pure state ψ_1. Further events are developed in reverse order but the dipole moment of the atom is oriented relative to the wave field so that the work is performed on it. This leads to reduction of energy of the atom and a contribution of ψ_1 to its state.

With the described method it thus is possible optically to illustrate multipolar interaction of higher and some other complicated processes in quantum ssystems.

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